3.2.3 Limit Values

The measured equivalent isotope radiation performance must not exceed the tolerance range of +/- 3 dB of the nominal value indicated by the manufacturer. The following are maximum values.

Frequency Range — Equiv. Isotope Radiation Perf.

Frequenzbereich	äquivalente isotrope Strahlungsleistung
a)	14 dBm (25 mW)
b)	27 dBm (500 mW)
c)	33 dBm (2 W)
d)	42 dBm (16 W)

2,4 - 2.5 GHz
24 - 24,24 GHz
61 - 61,5 GHz
76 - 77 GHz

3.3 Seized Band Width

The seized band width corresponds to the frequency difference determined by the distance between two envelope-curve points of the emission spectrum at which the equivalent isotope radiation performance remains below the value - 40dBc.

3.3.2 Measuring Procedure

The transmitter is operated under normal test conditions. The output of the transmitter must be connected via connecting power line with the input of the spectral analyst with the correct impedance.

The radio installation is operated so that the max. band width is seized.

The resolution band width of the spectrum analyst is combined

with the variability of the spectrum analyst until a perfect pulse spectrum is obtained. The latter must be noted in the test report.

With this band width, the transmission spectrum above and below the transmission frequency is investigated with regard to its compliance with the limit values.

3.3.3 Limit Values

Frequency Range	Limit Value of Seized Bandwidth
Frequenzbereich	Grenzwert belegte Bandbreite
a)	100 MHz
b)	250 MHz
c)	500 MHz
d)	1 GHz

3.4 Extended Emissions

3.4.1 Definition

Extended emissions are interfering radiations on one or several frequencies which are outside the required bandwidth and whose level can be lowered without affecting the respective transmission of an information. Extended emissions include harmonic emissions, parasitic emissions, intermodulation products as well as products of frequency conversion. They do not include out-of-band emissions.

The level of the extended emissions must be measured as effective radiation performance in the frequency range 30 MHz to 1GHz and as equivalent isotope radiation performance in the frequency range above 1 GHz.

3.4.2 Measuring Procedure

Extended emissions must be measured with an unmodulated transmitter.

Measurement of the effective radiation performance / equivalent isotope radiation performance of the tested device occurs at the measuring station which must meet the conditions described in 2.3.1.2 / 2.3.1.3. The transmitter is operated at the output measured in section 3.2, without modulation, on the firmly attached antenna, under normal test conditions. The radiation output of the extended emissions is determined via the test antenna with the measurement receiver outside the frequency range indicated in 2.1.1. Hereby, the electric radiation component is measured. At each frequency at which a secondary emission is noticed, the tested device must be turned until the max. of the extended emission is reached. Then the radiation performance of this extended emission is determined by a comparative measurement. The measurements must be repeated with the test signal D-TS3 and with orthogonal polarization of the tested antenna.

3.4.3 Limit Values

Frequency Range (MHz) Limit Values for Sec. Emissions

Frequenzbereich (MHz)	Grenzwerte für Nebenaussendungen
41 - 68 87,5 - 118 174 - 230 470 - 862	- 54 dBm
bis 10 000	- 36 dBm
oberhalb 10 000	- 30 dBm

3.5 Out-of-Band Emission

3.5.1 Definition

Out-of-band emissions are interfering radiation on one or several frequencies right outside the required band width but remaining inside the frequency ranges named in section 2.1.1.

3.5.2 Measuring Procedures

The measuring procedure described in 3.4.2 applies, but within the frequency range named in section 2.1.1.

3.5.3 Limit Values

With discrete frequencies, the performance of the out-of-band emissions must not exceed the following values:

Frequency Range — Limit Values for Out-of-Band Emissions

Frequenzbereich	Grenzwerte für Außerband-Aussendungen
a)	-26 dBm
b)	-13 dBm
c)	-7 dBm
d)	2 dBm

4. RECEIVER INTERFERING RADIATION

4.1 Definition

Receiver interfering radiations are high frequency emissions of the receiver as well as the antenna. The receiver interfering radiation is measured as:

a) The performance above 10 kHz supplier to an artificial antenna.

b) The effective radiation performance in the frequency range of 30 MHz to 1 GHz as equivalent isotope radiation performance in the frequency range above 1GHz.

4.2 Measuring Procedure

a) The level of the output supplier to the receiver input of each individual spectral component is measured with a spectrum analyst or a selective voltmeter.

b) Measurements of the effective radiation performance (equivalent isotope radiation performance of the tested device are taken at a measuring station which is in compliance with the conditions described in sections 2.3.1.2 / 2.3.1.3. The receiver is operated with an artificial antenna or a permanently attached antenna under normal test conditions. The radiation performance of the emissions is ascertained via the test antenna with the measurement receiver except for the used (effective?) channel and its adjoining channels. Hereby, the electric radiation component is measured. At each frequency at

which an interfering radiation is noticed, the tested device must be turned until the max. interfering radiation is reached. The measurements must be repeated with orthogonal polarization of the test antenna.

4.3 Limit Values

The receiver interfering radiation must not exceed the value indicated in the table:

Frequency Range Limit Values for the Receiver Interference Radiation

Frequenzbereich	Grenzwerte für die Empfängerstörstrahlung
bis 1 GHz	- 57 dBm
1 bis 10 GHz	- 47 dBm
oberhalb 10 GHz	-30 dBm

5. OTHER REQUIREMENTS

5.1 Radio Interference Voltage in the Frequency Range 10 kHz ... 30 MHZ

5.1.1 Definitions

Radio interference voltages in the sense of this licensing regulation are high-frequency voltages between the reference potential and the connection point for conductors (eg, transmission paths for telecommunication - or control signals, power lines, etc). Radio interference voltage measurements are not required for interior conductors of screened conductors which lead to screened components of the device when the screening is not interrupted.

5.1.2 Measuring Procedure and Measuring Instruments

To the ratio interference voltage apply the limit values represented in the following graph (page 13), which have been measured according to VDE 0877, Part 1, with measuring instruments and accessories according to VDE 0876, Part 1).

5.1.3 Limit Value Course

In the frequency range 150 kHz to 30 MHz, a differentiation is made between radio interferences with wide band frequency spectrum and radio interferences or discrete frequencies.

In the above graph, we have:

A = radio interference voltage with wide band frequency spectrum

B = radio interference voltage for individual spectral components on discrete frequencies.

In the frequency range 10 kHz to 150 kHz, no differentiation is made between radio interferences with wide band frequency spectrum and those on discrete frequencies.

5.2 Magnetic Interference Field Strength

5.2.1 Definition

The magnetic interference field strength is the magnetic component of the interference radiation which is measured by an antenna and a radio interference measurement receiver as magnetic field strength in the frequency range 10 kHz to 30 MHz.

5.2.2 Measuring Procedure

The magnetic interference field strength is measured in the frequency range 10 kHz to 30 MHz with measuring instruments according to VDE 0876, Part 1, under the conditions described in section 2.3.1.3. The tested device and the test antenna must be aligned in such a way that the max. interference field strength is recorded. Hereby must be noted that the measuring distance is accurately maintained as clear distance between the exterior dimensions of the tested device and the test antenna.

5.2.3 Limit Values

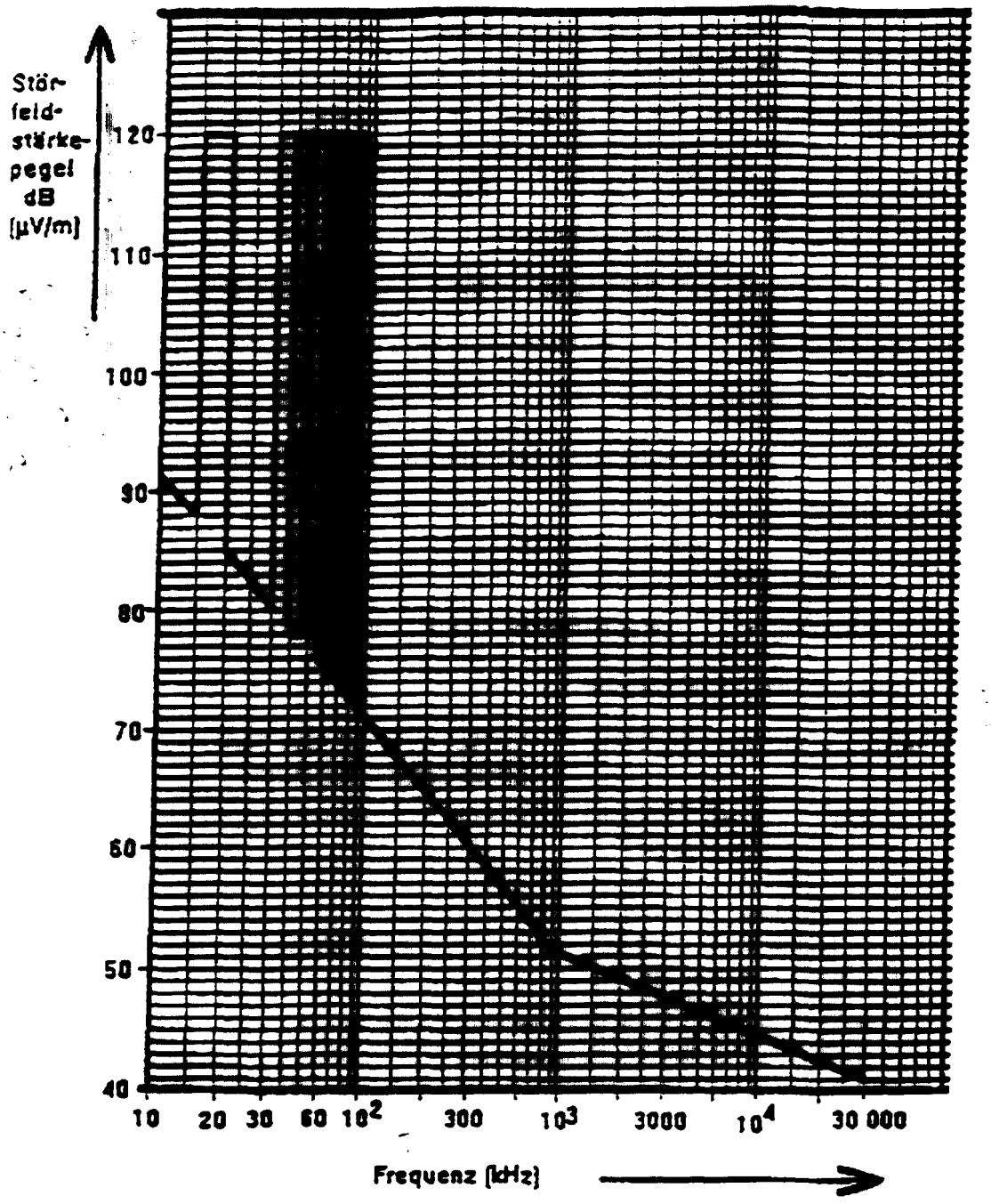
The magnetic interference field strength must not exceed the following values at a measuring distance of 30 m:

Frequency Range (+/- 1 kHz) Indication of the Radio Interference Measurement Receiver

Frequenzbereich (± 1kHz)	Anzeige im Funkstörmeßempfänger
15 kHz ... 19 kHz 30 kHz ... 38 kHz 45 kHz ... 57 kHz 62,5 kHz, 78,125 kHz, 93,75 kHz, 109,375 kHz 125,0 kHz, 140,625 kHz	65 dB (µV/m)
sonst von 10 kHz ... 30 MHz	34 dB (µV/m)

It is, however, recommended not to exceed the limit value indicated in the following graph which is measured at a distance of 3 m (near field).

Grenzwertverlauf



GERMAN STANDARD DRAFT

August 1991
DIN 40 050
Part 9

ROAD VEHICLES; DEGREES OF PROTECTION(IP-CODE); PROTECTION AGAINST FOREIGN OBJECTS; WATER AND CONTACTS; ELECTRICAL EQUIPMENT

Planned to replace the version 02.75

For connections with IEC 529.2, edition 1989 refer to Explanations (last page).

TABLE OF CONTENTS

****

1. **RANGE OF APPLICATION**

This standard applies to the IP types of protection for electrical equipment in road vehicles.

2. **PURPOSE**

The standard specifies the following:

- Designations and definitions of the IP-types and degrees of protection by way of housings for the electric equipment of road vehicles for the:

. protection of the electric equipment inside the housing against effects from the penetration of solid objects, including dust (protection against foreign matter);

. protection of the electrical equipment inside the housing against the effects from penetrating water (protection against water);

. protection of people against contact with dangerous components 1) inside the housing (protection against dangerous contact);

- Requirements of each protection degree.

- Test which need to be conducted to confirm that the housing meets the requirements of the respective degree of protection.

---

1) According to this standard, dangerous parts are moving, mechanical parts, except for smooth shafts.

---

3. STRUCTURE AND MEANING OF THE IP-CODE

3.1 Structure of the IP-code

Code letter (International Protection)	IP
1st characteristic number (numbers 0 to 6 or letter x)	2
2nd characteristic number (numbers 0 to 9 or letter x)	3
Additional letter (optional) (letters A,B,C,D)	C
Supplementary letter (optional) (letters M,S) (letter K) 2)	M

---

2) In connection with the first characteristic numbers 5 and 6 and the second characteristics numbers 4,6 and 9, the supplementary letter K follows right after the respective characteristics number).

When the characteristic number is missing, it must be placed by the letter "X" ("XX" if both characteristic numbers are missing).

Additional and/or supplementary letters may be eliminated without replacement. Consecutive letters must be arranged in alphabetical order (except for K; refer to 2).

When the degree of protection for a part of the housing or the electrical equipment deviated from that of the rest of the part, both degrees of protection have to be listed separately.

Examples of identification: refer to section 6.

3.2 Meaning of the IP-Code

Table 1 gives an overview of the IP-code elements.

Note: The supplementary letter K signifies the special regulations for road vehicles with regard to dust protection (first characteristic letter 5 and 6) and water protection (characteristics number 4, 6 and 9).

4. DEGREES OF PROTECTION AGAINST PENETRATING SOLID OBJECTS (INCLUDING DUST) AND AGAINST CONTACT WITH DANGEROUS PARTS

Tables 2 and 3 contain short descriptions of the degrees of protection and the respective requirements. The standard case is: equal degree of protection (equal characteristic number) against foreign objects and dangerous contact. In that case, both are characterized only by the first characteristic number.

Different degrees of protection for both types of protection can be determined by the use of additional letters, whereby the first characteristic number describes only the protection against foreign objects, the additional letter describes only the protection against dangerous contact.

Additional letters may only be used when

- the degree of protection against dangerous contact is higher than indicated by the first characteristic number, or

- when only the degree of protection against dangerous contact is to be given (first characteristic number replaced by x).

When indicating a degree of protection for contact and object protection, the respectively lower degrees of protection are included.

5. DEGREES OF PROTECTION AGAINST PENETRATING WATER

Table 4 contains short descriptions of the degree of protection and the respective requirements.

The protection degrees 1 to 6 K against water include the lower protection degrees. Due to different physical effects this need not automatically hold for the water protection degrees 7, 8 and 9 K.

But should this be the case, the included lower protection type must be identified separately, eg: IPX4K/IPX7, OPX5/IPX7, IPX6K/IPX8, IPX6K/IPX9K.

Table 1 - Overview of the IP-code Elements

1	component
2	number / letter
3	meaning for the protection of electrical equipment
4	meaning for the protection of people
5	against penetrating solid foreign objects (dust)
	not protected
	with ... (see table)
	protected against dust
	dustproof
6	against contact with dangerous parts (unless described by additional letters) with unprotected
	- top of hand
	- finger
	- tool
	- wire
	- wire
	- wire
7	against penetrating water
	unprotected
	vertical dripping
	dripping (15 degree slant)
	spray water
	splashing water
	splashing water at higher pressure
	water jet

strong water jet
strong water jet at higher pressure
temporary dipping
permanently immersed
high pressure / vapor jet cleaning

8 first charact. number
9 2nd " "

10 against contact with dangerous components (unless described by 1st charact. number) with
top of hand
finger
tool
wire
11 movement of movable part during the water test
standstill of movable parts during water test
specifically for electric equipment of road vehicles

12 additional letter (optional)
13 supplementary letter (optional)

---

3) new meaning of the letter A in IEC 529.2, 1988 ed.
4) In DIN 40050, part 9, ed. 2.75 regarding water protection, identified by A
5) e.g. rotor of an electric motor

Table 2 - Degrees of Protection against Foreign Objects

1 first characteristic number in part supplemented by letter K

2 - protection against penetration of ...
- not protected
- solid objects
....
- dust
...

3 short description

4 requirements
- none
- ball of dia. 50 mm must not penetrate completely
" 12.5 mm "

- rod of diam. 2.5 mm must not penetrate
- wire of 1.0 mm dia. "
- dust may penetrate only in amounts which do not affect the functionability and safety
- dust may not penetrate at all

Table 3 - Degrees of Protection against Contact with Dangerous Parts

1	first characteristic No. or added letter
2	protection against contact with - unprotected - top of hand (no protection against deliberate touch) - finger - tool (eg. screwdriver) - wire
3	short description
4	Requirements - none - ball of 50 mm dia. may not penetrate completely and must have sufficient distance from the dangerous parts. - segmented finger (finger of 12 mm dia. may penetrate but must have sufficient distance from dangerous parts. - rod with 2.5 mm dia. 100 mm long, but must have sufficient distance from dangerous parts - wire with 1.0 mm dia. 100 mm long may penetrate completely but must have sufficient distance from dangerous parts.

Table 4 - Degrees of Protection against Penetrating Water

1	2 charact. letter with supplemental letter K
2	protection against penetrating
0	not protected
1	dripping water
2	dripping water: with a 15-degree slant of the housing
3	spraying water
4	spraying water
4K	spraying water under higher pressure
5	jet water
6	strong jet of water
6K	strong jet under increased pressure
7	water with temporary dipping

8 water with permanent immersion
9K5) water during high pressure / vapor jet cleaning

Footnote 5): A water protection degree 9 without supplementary letter has not yet been established.

3 Requirements

0 none
1 vertically falling drops may not do any damage
2 " "
3 spraying water falling at an angle of up to 60 degrees to the vertical may not cause any damage
4 water spraying from any direction on the housing may not do any damage
4K water spraying from any direction on the housing at a higher pressure may not do any damage
5 water directed as a jet from any direction on the housing may not cause any damage
6 water directed as a strong jet from any direction on the housing may not cause any damage
6K water directed as a strong jet under increased pressure in any direction on the housing may not cause any damage
7 water may not penetrate to an amount which causes damage when the housing is temporarily under water at certain pressure and time conditions
8 water may not penetrate to an amount which causes damage when the housing is permanently under water at certain pressure and time conditions
9K5) water directed from any direction on the housing under greatly increased pressure, may not have any damaging effect.

6. EXAMPLES OF IDENTIFICATION

The IP-code must be used for the identification of the type of protection.

6.1 IP-Code with the Use of the Supplementary Letter K for the Protection against Water

Identification of a housing by mens of the IP-code IP34K signifies:

(3) - Protection of the electric equipment inside the housing against penetrating solid foreign objects of a diameter over 2.5 mm (foreign object protection); and

- Protection of people handling rods with a dia. of 2.5 mm and more against contact with dangerous parts inside the housing (contact protection).

(4K) - Protection of the electric equipment inside the housing against damaging effects of water which splashes on the housing from any direction under higher pressure (water protection).

SIEMENS
Telefax

June 24, 1993

Subject_ Specification of a FMCW-Radar front end for automobiles.

Dear Mr. Gruber:

First of all, thank you very much for your visit yesterday, the stimulating discussions and the impressive presentation.

As agreed, enclosed find a specification of the front end requested by us which should first be manufactured in wave guide technique to allow the shortest possible delivery time.

The same electric specifications apply to an integrated version of this front end. Only the environmental requirements and the dimensions of the housing would be different.

I would be most grateful for an offer on both versions including a detailed time schedule. I am available for any further questions you might have.

Expecting to hear from you soon, I remain,

With kind regards,

s/ Alfred Hoss

6.2 IP-Code with Use of the Additional Letter B and the Supplementary Letter K for Protection against Water

The identification of a housing by means of the IP-code IP16KB means:

(1) - Protection of the electric equipment inside the housing against penetrating solid foreign objects with a dia. of more than 50 mm (foreign body protection).

(6K) - Protection of the electric equipment inside the housing against damaging effects from water which splashes on the housing from any direction as a strong jet under increased pressure (water protection).

(B) - Protection of people against contact with dangerous parts inside the housing with the finger (contact protection).

6.3 Different IP-Codes for Different Parts of a Whole with the Use of a Supplementary Letter K for Dust Protection

The identifications

IP2X for the complete housing

IP5KX for covering a part inside the complete housing signify:

(2) - Protection of the electric equipment inside the complete housing against penetrating solid foreign objects with a dia. of more than 12.5 mm (foreign body protection).

- Protection of people against finger contact with dangerous components inside the complete housing (contact protection).

(X) - No statement regarding the degree of water protection for the whole housing.

And in addition:

(5K) - Protection of the part against damaging effects from penetrating dust (foreign body protection).

Note: When all the remaining parts are likewise not damaged by penetrating dust, the complete housing proves to have foreign object protection degree 2 and be dust-proof;

and

- Protection of people who handle wires of 1 mm diameter and more against contact with dangerous components inside the covering of that part (contact protection).

Note: This higher degree of contact protection of the covering of the part inside the complete housing has no bearing on the superimposed complete housing to which the lower protection degree 2 applies.

(X) - No statement with regard to the protection degree of water for the covering of this part.

7. REQUIREMENTS AND TESTS

7.1 Atmospheric Conditions

Unless a different agreement has been made, the tests must be conducted under the following conditions at ambient atmosphere:

Temperature range: (23 +/- 5)oC
Relative humidity: 25% to 75%
Air pressure: 86 kPa to 106 kPa (860 mbar to 1060 mbar).

7.2 Test Sample

Unless a different agreement has been made, the test samples must not be previously used and must be clean. Further requirements regarding the test samples may be agreed upon.

7.3 Requirements and Tests for the Degrees of Protection against Penetrating Solid Foreign Objects (including Dust and against Contact with Dangerous Parts.

7.3.1 Test Facilities

The test probes for proof of the protection degree against contact with and penetration by foreign objects are shown in table 6.

Note to table 6, balls with 50 mm or 122.5 mm dia:

Should protection and handle be proven out of place by a practical test, only the ball test should be applied.

A test facility (example) for testing the foreign object protection degrees 5K and 6K (protected against dust or dustproof) with vertical flow direction of the air-dust mixture is shown in figure 1a. Alternatively, also a dust chamber with horizontal flow direction (example: figure 1b), based on DIN V 40 046, part 48, can be agreed upon.

Table 8: Facilities and conditions for tests of the water protection degrees

2nd Characteristic Number possibly w.Supplementary Letters	Test Facility Test Conditions	Water Throughput	Water Pressure	Water Temperature	Test Duration
0	-	-	-	-	-
1	Dripping device Fig.2 Housing on turn table Revolution about 1/min.	(1.0+0.5)mm/min. (Precipitation rate)	-	Difference to the temp. of tested device no more than 5°C	10 min.
2	Dripping device Fig.2 Housing in 4 permanent positions on a 15°C slant	(3.0+0.5)mm/min. (Precipitation rate)	-	More than 5°C difference requires agreement	2.5 min.for each of the 4 positions
3	Pivoting tube Fig.3 with opening dia.0.4mm to +- 60°C from the vertical. Spraying in pivoting the tube by +- 60° from the vertical at about 1s/60° Maximum distance 200 mm	0.1 l/min.+-5% per opening (Average)	About 80kPa (Ref.to Note)	between the users of the standard to prevent form. of condensation water	10 min. (5 min.in 1 position, 5 min. in pos. turned to it by 90° around the vertical)
	or				
	or spraying shower Fig.4 Spraying in pivoting the shower by hand by +- 60° from the vertical Maximum distance 500 mm	10 l/min.+-5%	(50 to 150)kPa		1 min/m² Minimum 5 min.
4	Pivoting tube Fig.3 as No.3, but openings...+-90°..., Spraying ...+-180°...	As No.3	As No.3		As No.3
	Or spraying shower Fig.4, however, with movable covering removed, Spraying ...+-90°				
4K	Pivoting tube Fig.3 As No.3, but with op. dia. 0.8mm Spraying ... +- 180° ...	0.6l/min.+- 5% per opening (Average)	About 400kPa (Ref. Note)		10 min. (5 min. in 1 position, 5 min. in pos. turned to it by 90° around the vertical)
5	Water jet nozzle Fig.5 Nozzle 6.3 mm dia. Distance 2.5 m to 3 m	12.5 l/min.+-5%	About 30kPa (Ref. Note)		1 min./m² Minimum 3 min.

6	Water jet nozzle Fig.5 Nozzle 12.5 mm dia. Distance 2.5 m to 3 m	100 l/min. +- 5%	About 100kPa Ref. Note)	Difference to the temp. of tested device no more than 5°C	1 min/m² Minimum 3 min.
6K	Water jet nozzle Fig.5 Nozzle 6.3 mm dia. Distance 2.5 m to 3 m	75l/min.+- 5%		More than 5°C difference requires agreement	0.3min/m² Minimum 3 min.
7	Dip-in vats Dip-in depth: 1 m (lowest housing point) 0.15 m (highest housing point), when housing height greater than 0.85 m			between the users of the standard to prevent form. of cond.water	30 min.
8	Dip-in vat Water level: upon agreement between users of standard				Upon agreement
9K	Flat jet nozzle Fig.6a Housing on turntable Fig.6b Revolution No. (5+- 1)/min. Spraying below 0°, 30°, 60°, 90° Distance (100 to 150)mm	14 to 16 l/min.	About 10,000kPa	(80 +- 5)°C Deviating temperatures may be agreed upon	1 min/m², Minimum 30 s per position

NOTE:

- The test conditions "water throughput", "water pressure", "test duration", for IPX4K are in compliance with the specifications of E DIN IEC 50B(CO)266, 12.87, section 5.3.2.2 (Tables 5.1 and 5.2) and for IPX6K the specifications of E DIN IEC 50B(CO)266, 12.87, section 5.4.2 (Tables 7.1 and 7.2).

- As a rule, with the 2nd characteristic numbers 3 to 6K the necessary water pressure is set. At appropriate time intervals, it must be checked whether the necessary water throughput is reached or whether the operational pressure in the devices used needs to be adjusted.

Table 9: Examples for the correlation between the water protection degrees and vehicle types and assembly situations

Type of Vehicle	Mounting Location	Type of Water Impact	2nd Char.Number/ Supplementary Letters
Passenger Car	Passenger compartment Engine compartment covered on bottom	No special impact No impact from splashing and and water jet. Only light spray/fog at some insignificant places	0 3
	Engine compartment open on bottom, protected places	Splashing water and jet can impact only indirectly (after redirecting)	4
	Engine compartment open on bottom, exposed places	Splashing water and jet can impact directly	4K
	Outside mounting	Splashing water and jet can impact directly	4K
Busses and	Passenger compartment, Cab	No special impact	0
Commercial vehicles, Specialty vehicles and towing vehicles for road traffic and respective trailers	Front engine compartment Protected places; Closed rear engine compartment	Splashing water and jet can impact only indirectly (after redirecting)	4
	Front engine compartment, Exposed places; Unprotected undercarriage	Splashing water and jet can impact directly	4K
	Places impacted by very strong water jets (e.g., during cleaning before repairs)	Water jets under especially high pressure	6K
	Outside mounting	Splashing water and jet can impact directly	4K
Tractors and their Trailers	Instrument panel in tractor with roof only	No special impact	0
	Instrument panel in tractor without roof	Rain impact	3
	All uncovered areas (except for instrument panel)	Splashing water and jet can impact	4K